



DEC 18 2017

L-2017-206
10 CFR 50.73

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Re: St. Lucie Unit 2
Docket No. 50-389
Reportable Event: 2017-004-00
Date of Event: October 26, 2017
Automatic Reactor Trip due to Turbine Control System Malfunction

Licensee Event Report 2017-004-00 is being submitted pursuant to the requirements of 10 CFR 50.73 to provide notification of the subject event.

Respectfully,

A handwritten signature in cursive script that reads "Daniel DeBoer".

Daniel DeBoer
Site Director
St. Lucie Plant

DD/rcs

Attachment

cc: USNRC Regional Administrator, Region II
USNRC Senior Resident Inspector, St. Lucie Nuclear Plant



LICENSEE EVENT REPORT (LER)

(See Page 2 for required number of digits/characters for each block)

Estimated burden per response to comply with this mandatory collection request: 80 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the FOIA, Privacy and Information Collections Branch (T-5 F53), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by e-mail to Infocollects.Resource@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

1. FACILITY NAME St. Lucie Unit 2	2. DOCKET NUMBER 05000389	3. PAGE 1 of 4
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4. TITLE
Automatic Reactor Trip due to Turbine Control System Malfunction

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
10	26	2017	2017	004	0	12	18	2017	FACILITY NAME	DOCKET NUMBER
									FACILITY NAME	DOCKET NUMBER

9. OPERATING MODE **11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply)**

1	<input type="checkbox"/> 20.2201(b)	<input type="checkbox"/> 20.2203(a)(3)(i)	<input type="checkbox"/> 50.73(a)(2)(ii)(A)	<input type="checkbox"/> 50.73(a)(2)(viii)(A)
	<input type="checkbox"/> 20.2201(d)	<input type="checkbox"/> 20.2203(a)(3)(ii)	<input type="checkbox"/> 50.73(a)(2)(ii)(B)	<input type="checkbox"/> 50.73(a)(2)(viii)(B)
	<input type="checkbox"/> 20.2203(a)(1)	<input type="checkbox"/> 20.2203(a)(4)	<input type="checkbox"/> 50.73(a)(2)(iii)	<input type="checkbox"/> 50.73(a)(2)(ix)(A)
	<input type="checkbox"/> 20.2203(a)(2)(i)	<input type="checkbox"/> 50.36(c)(1)(i)(A)	<input checked="" type="checkbox"/> 50.73(a)(2)(iv)(A)	<input type="checkbox"/> 50.73(a)(2)(x)
100	<input type="checkbox"/> 20.2203(a)(2)(ii)	<input type="checkbox"/> 50.36(c)(1)(ii)(A)	<input type="checkbox"/> 50.73(a)(2)(v)(A)	<input type="checkbox"/> 73.71(a)(4)
	<input type="checkbox"/> 20.2203(a)(2)(iii)	<input type="checkbox"/> 50.36(c)(2)	<input type="checkbox"/> 50.73(a)(2)(v)(B)	<input type="checkbox"/> 73.71(a)(5)
	<input type="checkbox"/> 20.2203(a)(2)(iv)	<input type="checkbox"/> 50.46(a)(3)(ii)	<input type="checkbox"/> 50.73(a)(2)(v)(C)	<input type="checkbox"/> 73.77(a)(1)
	<input type="checkbox"/> 20.2203(a)(2)(v)	<input type="checkbox"/> 50.73(a)(2)(i)(A)	<input type="checkbox"/> 50.73(a)(2)(v)(D)	<input type="checkbox"/> 73.77(a)(2)(i)
	<input type="checkbox"/> 20.2203(a)(2)(vi)	<input type="checkbox"/> 50.73(a)(2)(i)(B)	<input type="checkbox"/> 50.73(a)(2)(vii)	<input type="checkbox"/> 73.77(a)(2)(ii)
		<input type="checkbox"/> 50.73(a)(2)(i)(C)	<input type="checkbox"/> OTHER	Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

LICENSEE CONTACT Richard Sciscente – Licensing Engineer	TELEPHONE NUMBER (Include Area Code) (772) 467-7748
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13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
B	TG	DCC	E232	YES	B	JB	ISV	P070	YES
B	JB	LCV	E232	YES					

14. SUPPLEMENTAL REPORT EXPECTED <input type="checkbox"/> YES (If yes, complete 15. EXPECTED SUBMISSION DATE) <input checked="" type="checkbox"/> NO	15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)

On October 26, 2017, at 0212 hours with St. Lucie Unit 2 in Mode 1 at 100% power, the reactor automatically tripped due to a loss of load following a failure within the turbine control system. The reactor trip was uncomplicated and all control rod assemblies fully inserted. Following the trip, one of the low power feedwater valves LCV-9005, did not properly maintain steam generator level which resulted in an actuation of the A-train auxiliary feedwater system. During the auxiliary feedwater actuation, one main feedwater isolation valve did not reposition closed as expected, but this did not impact heat removal. The main feedwater system remained available.

The failure within the turbine control system was caused by design deficiencies. Planned corrective actions include modifications to improve protective circuits, the addition of coolers and use of conformal coatings on printed circuit boards in the modules.

The problem with LCV-9005 was due to a latent design error that resulted in the setting of an incorrect stroke length for the control valve. This was corrected by adjusting the stroke length of the valve.

This report is being reported in accordance with 10 CFR 50.73(a)(2)(iv)(A) for system actuations of the reactor protection system and the auxiliary feedwater system.

During this event offsite power remained operable and energized. All other equipment responded to the event as expected per the existing plant conditions; therefore, this event had no impact on the health and safety of the public.



**LICENSEE EVENT REPORT (LER)
CONTINUATION SHEET**

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1. FACILITY NAME	2. DOCKET	6. LER NUMBER		
St. Lucie Unit 2	05000389	YEAR	SEQUENTIAL NUMBER	REV NO.
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NARRATIVE

Description

On October 26, 2017, at 0212 hours with St. Lucie Unit 2 in Mode 1 at 100% power, the reactor automatically tripped due to a loss of load following a failure within the non-safety related turbine control system (TCS) [EIS:TG:DCC]. Based on initial investigation, it was determined that a TCS malfunction affected multiple testable dump manifold (TDM) solenoids [EIS:TG:PSV]. Ultimately, electro-hydraulic (EH) [EIS:TG] system pressure was lost (i.e., turbine tripped) after two TDM 1 solenoids spuriously operated concurrently. All high pressure turbine governor and throttle valves [EIS:TA:XCV] and all low pressure turbine intercept and reheat stop valves [EIS:TA:SHV] repositioned closed as expected upon loss of EH pressure. The reactor trip was uncomplicated and all control rod assemblies fully inserted.

Following the reactor trip, the 15% bypass feedwater regulating valve, LCV-9005 [EIS:JB:LCV], did not provide the expected feedwater flow to the 2A Steam Generator [EIS:JB:SG]. This resulted in lowering steam generator level and an actuation of the A train auxiliary feedwater actuation system (AFAS) [EIS:JC]. During the auxiliary feedwater actuation, one main feedwater isolation valve (MFIV) [EIS:JB:ISV], HCV-09-1A, did not reposition closed as expected, but this did not impact heat removal as the redundant MFIV in series isolated main feedwater. The main feedwater system remained available.

Cause of the Event

The failure within the turbine control system was caused by design deficiencies. The TCS incorporates various features for fault tolerance, including the use of three separate trip circuits for each TDM, the 2 out of 3 hydraulic logic of the TDM design, and redundant datalinks provided for Remote I/O communications. The design is intended to ensure a single failure or malfunction will not result in turbine trip. Replaced modules were retained for analysis. Two sets were sent to the original equipment manufacturer. The third set was sent to an independent lab for forensic analysis. Based on the results of the forensic analyses, this report may be supplemented with additional causal factors as appropriate.

The problem with LCV-9005 was due to a latent design error that resulted in the setting of an incorrect stroke length for the control valve. The stroke length of LCV-9005 has been properly adjusted.

The problem with HCV-09-1A was caused by a failed solenoid, and the solenoid was replaced.

Analysis of the Event

This licensee event report is being reported in accordance with 10 CFR 50.73(a)(2)(iv)(A) as "Any event or condition that resulted in manual or automatic actuation of any of the systems listed in paragraph (a)(2)(iv)(B)." This event included automatic actuations of the reactor protection system and the auxiliary feedwater system.

Testable Dump Manifolds

The TCS has automatic control and trip devices necessary for operation and protection of the turbine-generator. An automatic trip is provided to prevent any damage to the turbine-generator. The unit trips upon occurrence of conditions which are potentially hazardous to the turbine-generator or to other associated plant equipment. The TCS uses two headers to provide emergency turbine trip and overspeed protection. The emergency trip header has two testable dump manifolds (TDM 1 and TDM 2) and the overspeed protection header has one testable dump manifold (TDM 3). Each triple redundant electronic emergency trip system uses a TDM to interface with the control oil system. The 2-out-of-3 solenoid logic used to provide a protective trip also provides a means to test the system while on-line.



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Reviews of EH pressure data at each TDM showed that TDM 1 solenoid B was momentarily spuriously opening during the night prior to the event, and also that TDM 1 solenoid A and TDM 2 solenoid C had momentarily opened over the same time period. Approximately 30 minutes prior to the trip, TDM1 solenoid B opened and stayed open, putting TDM 1 into a continuous half trip state. The trip occurred after a second solenoid on TDM 1 spuriously opened.

Auxiliary Feedwater Actuation

LCV-9005 and LCV-9006 are a pair of non-safety related 15% bypass feedwater regulating valves supplying main feedwater flow to the 2A and 2B SGs respectively with a predetermined set point and flow rate post trip. In 1997, LCV-9005 was replaced with what was intended to be a like for like valve replacement. However, the replacement LCV-9005 had different flow characteristics and a different stroke length that was not properly documented; therefore, not properly setup.

Prior to its replacement in 1997, LCV-9005 had a stroke length of 1.5 inches. The replacement valve had a stroke length of 2 inches. Stroke length is used to set up the control of the valve flow rate characteristics. Therefore, the new model valve was only opening a percentage of a 1.5 inch stroke length instead of 2 inches. This resulted in less flow than needed to automatically maintain flow to the steam generator without manual operation. A change in the plant conditions following implementation of a low power feedwater digital controller in 2013 compounded the effect of shortened valve stroke length that became apparent during this plant trip. The opposite train valve LCV-9006 was determined to be operating with the proper stroke length, and main feedwater was used to feed the 2B Steam Generator post trip.

Safety Significance

The digital signals sent by the TCS to the TDMs during this event were reviewed and determined to be invalid and spurious. The turbine was not damaged or exposed to hazardous conditions during this event.

The auxiliary feedwater system is provided with complete sensor and control instrumentation to enable the system to automatically respond to a loss of steam generator inventory. Due to the incorrect setting of LCV-9005 and the lowering water level in the 2A steam generator, the AFAS-1 actuation was valid. Once the mismatched 15% bypass feedwater regulating valve was isolated by AFAS-1, water level in the 2A steam generator was restored using auxiliary feedwater. 2B steam generator level was maintained post trip via LCV-9006 and main feedwater.

During the auxiliary feedwater actuation, one of two MFIVs did not reposition closed as expected. There are two MFIVs in series on each feedwater train (A and B). The 2A train of main feedwater was automatically isolated by at least one MFIV. The Unit 2 UFSAR Table 7.3-12 describes failure modes and effects for the auxiliary feedwater actuation system. This analysis bounds the observation of the event described in this LER.

During this event offsite power remained operable and energized. Loss of turbine load events are bounded in the UFSAR as anticipated operational conditions. All other equipment responded to the event as expected per the existing plant conditions; therefore, this event had no impact on the health and safety of the public.

Corrective Actions

The corrective actions listed below are either completed or are being managed under the Corrective Action Program:

1. The three digital output modules controlling solenoids for TDM 1 were replaced, each consisting of an Electronics Module (EMOD), Personality Module (PMOD) and base assembly.



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2. The digital output module EMOD and PMOD for TDM 2 solenoid C was also replaced, as there was evidence that this solenoid had spuriously opened prior to the event.
3. The removed digital output modules were retained for analysis. Two sets (EMOD/PMOD/Base) from TDM 1 were sent to Emerson. The third set from TDM 1 was sent to an independent lab for forensic analysis.
4. Additional countermeasures measures were taken to further protect the TCS remote I/O cabinets from the environment. This included improving the remote TCS cabinets' environmental protection.
5. Actions are planned to install coolers for TCS cabinets.
6. Actions are planned to replace circuit card components in Remote I/O Cabinets.
7. Actions are planned to implement redundancy and diagnostics modifications to the TCS.
8. The stroke length of LCV-9005 was properly adjusted for a 2-inch stroke.
9. The failed solenoid on HCV-09-1A was replaced.

Failed Components Identified

Turbine Control System Digital Output Module - Electronics Module (EMOD)

Description: Digital Output 5-60VDC EMOD
 Manufacturer: Emerson
 Emerson Style Number: 1C31122G01
 EMOD Serial Number: 3611019514
 Emerson EMOD Module Revision 10

Turbine Control System Digital Output Module - Personality Module (PMOD)

Description: Digital Output PMOD
 Manufacturer Emerson
 Emerson Style Number: 1C31125G02
 PMOD Serial Number: T104316024
 Emerson PMOD Module Revision 06

15% Bypass Feedwater Regulating Valve

Manufacturer: Fisher Controls Co Inc. (Emerson)
 Valve Serial Number: 4" - 52A7148

Main Feedwater Isolation Valve Solenoid

Description: valve:solenoid,3-way, 1/8" FNPT conn, carbon steel, 120 VDC,90 psi, normally closed
 Manufacturer: Parker Hannifin
 Part Number V5H71970
 Cat ID322057-1

Additional Information

None